GUIDE
TO THE MOLLUSCA

EXHIBITED IN THE

ZOOLOGICAL DEPARTMENT,

BRITISH MUSEUM (NATURAL HISTORY).

ILLUSTRATED BY 47 FIGURES.

LONDON:

PRINTED BY ORDER OF THE TRUSTEES

OF THE BRITISH MUSEUM.

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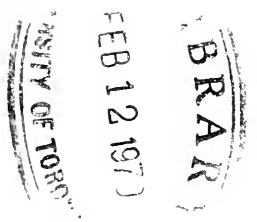

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PREFACE.

One of the large galleries to the north of the Bird Gallery is devoted to the exhibition of the Mollusca. This extensive group includes nearly 60,000 living species; most of these are represented in the Museum Collection, which consists of over 600,000 specimens. Models or spirit specimens of examples of all the principal divisions are exhibited, and the models of an Octopus and of the Giant Squid are the most conspicuous objects in the Gallery. The shells of molluscs are a favourite object of study and a source of pleasure to collectors, and the exhibition of shells has been made as complete as possible, so as to be adequate for the requirements of the majority of students and visitors. The shells are arranged in systematic order in the series of table-cases; in addition a separate series of British Shells is displayed in some table-cases near the west wall, and an instructive exhibit, prepared by Mr. B. B. Woodward, illustrating the modifications of structure, form, sculpture, &c., in the shells of Mollusca is placed in wall-cases on the same side of the Gallery.

This Guide-book has been prepared by Mr. G. C. Robson, M.A. It is to a large extent based on the late Mr. E. A. Smith's contribution to the old *Guide to the Shell and Starfish Galleries*, but it has been rewritten and much new matter has been introduced.

Thanks are due to Messrs. A. & C. Black, Messrs. Macmillan & Co., and Crosby Lockwood & Son, for kindly allowing the use of *clichés* from illustrations in various works published by them.

C. TATE REGAN,
Keeper of Zoology.

British Museum (Natural History),
London, S.W. 7.
March 1923.

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GUIDE TO THE MOLLUSCA.

INTRODUCTION.

General.

The Mollusca constitute one of the phyla, or principal divisions of the Animal Kingdom, and include such forms as the Whelk, Snail, Slug, Oyster, and Octopus. They are distributed all over the world and are to be found in the sea, in fresh water, and on land.

The phylum is very sharply defined and its relationships are obscure: it would seem to have some distant affinity with the Annelida or segmented worms.

Although such animals as the Snail, the Oyster, and the Octopus may, at first sight, appear to have little in common, all Mollusca nevertheless resemble one another in the fundamental plan of their structure. They are soft-bodied, unsegmented, invertebrate animals with a muscular projection on the under side, the 'foot', which serves for locomotion, and with the skin of the back, the 'mantle', overhanging at the sides as a flap or fold, the space beneath which is known as the mantle-cavity. The mantle nearly always secretes a calcareous shell, and the organs of respiration, whether gills or lung, are usually situated in the mantle-cavity. The Mollusca have a heart and blood-vessels, a complex nervous system, and, in all those that have a definite head, a characteristic rasping organ, the 'radula', within the mouth.

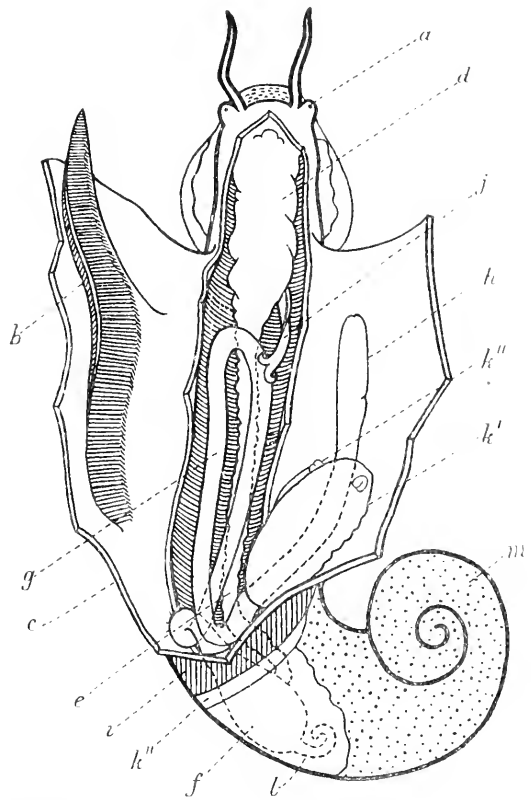
This definition leaves out of account certain highly specialized and parasitic Mollusca in which the structures mentioned are not found in the adult, although they, or their rudiments, may be present in the young.

The shell is the most striking feature of most Mollusca, and the various forms it assumes provided a basis for the older classifications of the group. It is in one piece (univalve) and nearly always spirally coiled in the Gastropoda (Snails, Slugs, Whelks, and the like); of two pieces (bivalve) in the Lamellibranchia (Oysters, Mussels, Cockles, &c.); and concealed within the soft tissues in nearly all existing Cephalopoda (Squids, Octopus). The vast majority of Mollusca belong to one or other of these three great divisions, but a few remain over which are grouped as

Amphineura (Chitons or 'coat-of-mail' shells) and Scaphopoda (Tusk-shells).

Certain animals belonging to other divisions of the Animal Kingdom have shells that resemble more or less closely those of

Fig. 1.



General anatomy of *Trochus* (×3) showing the position of some of the more important organs.

a. eye; *b*. gill; *c*. cut edge of mantle; *d*. crop; *e*. oesophagus; *f*. stomach; *g*. intestine; *h*. rectum; *i*. pericardium; *j*. radula sac; *k k''*. kidneys; *l*. liver; *m*. genital gland.

Mollusca, and were, therefore, associated with the latter by the older naturalists. Such are the Lamp-shells (Brachiopoda), which superficially resemble Lamellibranchs but differ widely in their internal structure, and the Barnacles (Cirripedia), which are greatly modified Crustacea.

Classification.

A table of the main divisions of the Mollusca according to the system of classification adopted in the arrangement of the gallery is given below. The names of a few typical genera are mentioned as examples under each of the orders.

Phylum **MOLLUSCA.**

Class I. AMPHINEURA.

Order 1. Polyplacophora : *Chiton*.

2. Aplacophora : *Neomenia*, *Chaetoderma*.

Class II. GASTROPODA.

Sub-class I. Streptoneura.

Order 1. Aspidobranchia :
Patella (Limpet), *Haliotis* (Ormer), *Turbo* (Top-shell).

2. Pectinibranchia :
Littorina (Periwinkle), *Vivipara* (River Snail), *Cypraea* (Cowry), *Buccinum* (Whelk), *Carinaria* (Heteropoda).

Sub-class II. Euthyneura.

Order 3. Opisthobranchia :
Bulla (Bubble-shell), *Aplysia* (Sea-Hare), *Nudibranchia* (Sea-Slugs), *Clione* (Pteropoda or Sea-Butterflies).

4. Pulmonata :
Siphonaria (False Limpet), *Limnaea* (Water Snail), *Helix* (True Snail).

Class III. SCAPHOPODA.
Dentalium (Tusk-shell).

Class IV. LAMELLIBRANCHIA.

Order 1. Protobranchia : *Nucula*.

2. Filibranchia : *Mytilus* (Mussel), *Pecten* (Scallop).

3. Eulamellibranchia : *Ostraea* (Oyster), *Cardium* (Cockle), *Teredo* (Shipworm).

4. Septibranchia : *Cuspidaria*.

Class V. CEPHALOPODA.

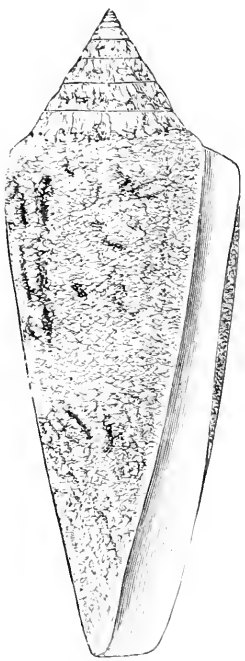
Order 1. Tetrabranchia : *Nautilus*, *Ammonites*.

2. Dibranchia : *Loligo* (Squid), *Sepia* (Cuttlefish), *Polypus* (Octopus), *Belemnites*.

Structure.

In nearly all the Mollusca the body is divisible into three main regions, the head, the foot, and the visceral sac which is covered by the mantle. In the Lamellibranchia the head is hardly developed at all, while in the Cephalopoda it is surrounded by

Fig. 2.



The 'Glory-of-the-Sea' Cone (*Conus gloria-maris*). Case 94.
(From the Philippine Islands.)

and coalesced with the foot, the edges of which form a circle of sucker-bearing arms.

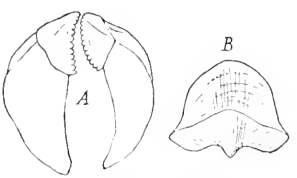
The *foot* is variously modified for creeping, digging, and other purposes. In the Pteropoda or Sea-Butterflies the sides of the foot are expanded to form large fins.

The term *mantle* is sometimes restricted to the out-growing folds at the sides of the body, but is more correctly applied to the entire covering of the visceral sac. The free folds may be restricted in extent by coalescence with the body, and the cavity they enclose may thus vary greatly in size and position.

The *shell* is secreted by the outer surface of the mantle, but may be enveloped by the mantle so as to become partly or altogether an internal structure. It is formed of a horny substance (conchiolin) impregnated with carbonate of lime. As a rule two layers can be distinguished, differing in their minute structure and in their mineralogical constitution. In the outer or prismatic layer, which forms most of the thickness of the shell, the carbonate of lime is in the form of calcite. In the inner or nacreous layer ('mother-of-pearl') it is in the harder form of aragonite. An outer skin (periostracum) is frequently present. In some molluscs the mineral constituents are reduced or absent and the shell is 'horny' and flexible, and in some others the shell is entirely absent.

There are one or two exceptions to the rule that molluscan shells are secreted by the mantle. In the Cephalopod *Argonauta*, as will be explained later, a spiral shell is produced by secretion

Fig. 3.



Mandibles of Gastropoda. A. *Janus*; B. dorsal mandible of *Aegirus*. From Lankester's *Treatise of Zoology* (by permission of Messrs. A. & C. Black).

from two of the arms, while the under surface of the foot secretes a calcareous plate in the Gastropod *Hipponyx*. The modifications of the shell in the various classes will be described in the systematic survey (p. 19), but the visitor's attention may here be called to the exhibit in Wall-case A, where the main points of shell-structure and the more remarkable changes of form throughout the phylum are illustrated.

Although the shells of many families are highly characteristic, there are several examples of molluscs of widely different structure and systematic position that have shells resembling each other, and classifications based on the shell are subject to change with increasing anatomical knowledge.

Certain molluscs have internal skeletal structures. The head cartilages of the Cephalopoda and the cartilaginous supports of the radula in the Gastropoda are of this nature.

The *alimentary* canal is usually differentiated into a mouth, pharynx, oesophagus, stomach, and intestine. The liver opens by one or more ducts into the stomach, and salivary glands are invariably present. The names 'liver' and 'salivary glands'

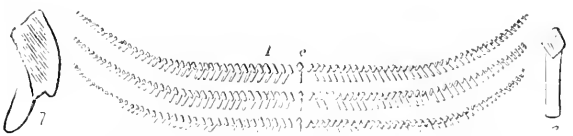
must not be taken to imply that their secretions are of exactly the same nature as the secretions of these organs in the Vertebrates.

Horny jaw-plates (mandibles), which may be paired or single, are found in all molluscs except Lamellibranchs and most of the Amphineura.

Behind these jaw-plates is the radula, which is generally present except in the Lamellibranchia. This is a tongue-like organ beset with numerous transverse rows of minute teeth. The form and arrangement of the teeth are highly characteristic, and in the Gastropoda they have been made the basis of the classification of part of the group.

In some Gastropoda and most Lamellibranchia a second characteristic structure, the crystalline style, is found in the stomach or in a sac at the junction of the stomach and the intestine. It is a more or less elongated rod of semi-gelatinous substance. It is believed to provide a digestive ferment.

FIG. 4.



Three rows of Teeth of the Radula of *Siphonaria*.
c. central; *l*. lateral teeth.

The *circulatory system* consists of a heart composed of a ventricle and one or more auricles, blood-vessels, and blood sinuses. The last are large, irregular spaces in the connective tissue between the various organs and may possibly represent in part the capillary system of other animals. The blood is usually colourless, but in certain cases it is red or blue owing to the presence of haemoglobin or of haemocyanin.

The *respiratory organs* of the Mollusca are usually gills, but in certain cases these are replaced by other organs. The typical gills (ctenidia) consist of a number of filaments or flattened plates arranged along a main axis and suspended from the roof of the mantle-cavity. Important modifications of the gills occur in the Lamellibranchs. In many molluscs the gill is lost and the mantle-cavity is adapted as a lung for breathing air; in others the typical gills are suppressed and 'false gills' are developed from the mantle, whilst in a few there are no gills at all and respiration is carried on by the general surface of the body.

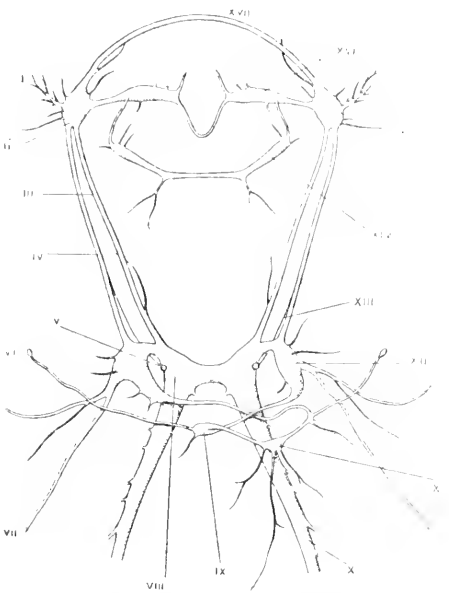
The *nervous system* consists of several pairs of ganglia, nerve-cords and sense-organs. The most important ganglia are the cerebral, the pedal, the pleural, and the visceral. These are joined in various ways by connecting cords ('commissures').

Although there is no brain in the strict sense of the word there is sometimes a concentration of ganglia at the anterior end which may become so intimate as to constitute a solid mass.

A considerable variety of sense-organs is present, of which we can only mention the principal ones.

Eyes, of greater or less complexity, are developed, most often in the region of the head, but sometimes on the mantle. The

Fig. 5.



Central nervous system of *Patella vulgata*, dorsal aspect.

I. tentacular nerve; II. cerebral ganglion; III. cerebro-pedal connective; IV. cerebro-pleural connective; VIII. pedal ganglion; IX. visceral commissure; XI. abdominal ganglion; XII. pallial ganglion; XIV. stomatogastric ganglion; XVII. cerebral commissure.

From Lankester's *Treatise on Zoology* (by permission of Messrs A. & C. Black).

remarkable eyes of some Cephalopoda rival those of Vertebrates in the elaboration of their structure.

Organs of smell (osphradia, rhinophores) are found on the head or, in aquatic forms, at the entrance to the mantle-cavity, near the gills.

Otocysts are found in most molluscs in the tissues of the foot. They may, as was formerly believed, be organs of hearing, but they are more probably connected with the sense of balance and direction.

Renal organs (kidneys) are found in all molluscs, usually in intimate connexion with the pericardium and reproductive organs. In certain forms they act as genital ducts as well as kidneys. In general structure they are glandular sacs, the walls of which are increased by extensive folding. The liver sometimes acts as an excretory organ, and certain of its cells may be specialized for that purpose.

The genital ducts may be simple or may have an elaborate apparatus of accessory glands and other organs. In the Aplacophora and certain Gastropoda there are no genital ducts and the germ cells are liberated through the renal ducts.

Reproduction and Development.

The *sexes* are usually separate, but hermaphroditism occurs in nearly all the classes, and the Euthyneura among the Gastropoda are exclusively hermaphrodite. In a few molluscs the animal passes through a regular sexual cycle, being male at one period and female at another. This occurs in the Limpet (*Patella*), in *Crepidula* and probably in *Aplysia* among Gastropoda, and in the Common Oyster among Lamellibranchia. Hermaphrodite species are usually cross-fertilized, but self-fertilization sometimes occurs. Only one case of parthenogenesis is known, that of the Gastropod *Paludestrina jenkinsi*. The males and females of bisexual forms are sometimes distinguished by the size and shape of their shells.

Fertilization is either external or internal. The former is usually the rule among marine forms, in which the number of eggs discharged from the ovary may be enormous, the Common Oyster depositing as many as 60,000,000. In most aquatic Mollusca the young pass through a series of free-swimming larval stages. The first stage is usually that known as the Trochosphere, which resembles very closely the earliest larval stage of certain Annelid worms. Later a lobed swimming-organ, the velum, is developed and the larva is termed a Veliger. In all terrestrial molluscs and in certain aquatic forms, such as some Cephalopoda, the eggs are few and large and develop directly, the larval stages being suppressed.

The large eggs of some terrestrial molluscs may have a calcareous shell. In numerous cases the eggs are laid in clusters or in ribbons, which take on various shapes (Wall-cases B and E).

There is a great variety of parental care among Mollusca, from a mere temporary association with the parent, as in some Gastropods in which the eggs are laid on the shell, to continuous incubation in special brood-pouches in the mother's body as in the Pond-Snail *Viripara*. In certain Lamellibranchia—the Unionidae, Cyrenidae, &c.—the young are incubated between

the gill lamellae, while the Paper-Nautilus, *Argonauta*, secretes a special shell from the dorsal tentacles, in which the young develop.

Special courtship habits are not unknown among Mollusca, and in the common Slugs (Limacidae) and Snails (Helicidae) these proceedings may be prolonged and complicated.

Habits.

The Mollusca are characteristically slow-moving and 'sluggish', but nearly all have some power of locomotion, by swimming, creeping, or burrowing. The Cephalopoda are active and powerful swimmers.

The number of forms which are actually fixed down is very small. A good many Lamellibranchs may be temporarily anchored, but some, like the Oyster, are permanently attached by the shell.

The muscular strength of some Molluscs is known to be very great. The Common Limpet, for example, can resist a pull of 62 lb.

The food of Mollusca and their methods of feeding are very varied. Where a radula is present it is generally used for rasping off portions of plant or animal tissues, but the Lamellibranchia and a few Gastropoda feed upon minute floating life (plankton) or on organic particles which are drawn in by the movements of vibratile hairs (cilia) on the gills and mantle. Those molluscs that are definitely carnivorous generally prey upon sessile invertebrates such as the Coelenterates, Sponges, and Tunicates, or upon other Mollusca, but the active Cephalopods pursue and capture fishes and Crustacea.

Many molluscs live in more or less close association with corals, Sponges, and other animals, although cases of actual parasitism are few. Some Gastropods are external parasites of Echinoderms, while a few Gastropods and Lamellibranchs are highly degenerate internal parasites of Holothurians. In their turn, molluscs are the hosts of very many external and internal parasites.

A remarkable instance of molluscs that utilize for their own defence the organs of their prey is that of the Nudibranch Gastropods of the family Eolididae. These feed on Hydroids and other Coelenterates, and the stinging cells (nematocysts) of the latter are stored up in the dorsal appendages of the Eolids, from which they are expelled when the animal is attacked.

Mollusca form the characteristic food of numerous other animals. The Greenland Whale, which feeds upon plankton organisms, swallows vast quantities of Pteropods. Other whales, such as the Sperm Whale, live mainly on Cephalopods, and the beaks and other parts of these molluscs may be found in their

stomachs. Many fishes feed upon marine Gastropods and Lamellibranchs. Sea-birds feed upon littoral forms between tide-marks and in coastal lagoons and backwaters. Petrels will seize and eat pelagic Cephalopoda. Land-Snails are eaten by numerous birds, notably the Thrush, and also by mammals such as mice, badgers, and hedgehogs. Crabs, lobsters, beetles, and starfish are among the invertebrate enemies of Mollusca. Young Lamellibranchs are said to be the exclusive food of the Annelid *Magelona*.

The age to which Mollusca live varies very considerably. Precise figures are available for some Gastropoda and Lamellibranchia, and of these it appears that the latter may live longer. Certain freshwater Mussels (*Anodonta*) are said to reach the age of 20–30 years. The Common Oyster may live for 10 years. Of Gastropoda, *Helix* reaches the age of 6 or 7 years, *Paludina* 8 years, while the Common Periwinkle has lived in captivity for nearly 20 years. The beautiful Nudibranchs do not appear to be so long-lived as other Gastropoda. Sexual

Fig. 6.

Helix desertorum. From Woodward's *Manual of the Mollusca* (by permission of Crosby Lockwood & Son).

maturity in Gastropoda may be attained in the year of birth. The Common Limpet, *Patella vulgata*, is mature when less than an inch long. After that it continues to grow and sometimes attains a length of over 2½ inches. Two-thirds of its final size may therefore be developed after sexual maturity.

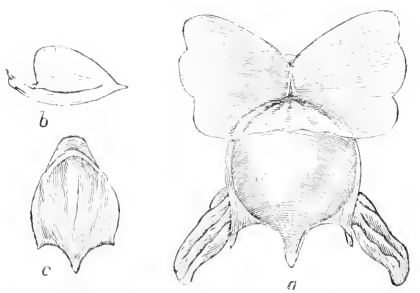
The resistance of Mollusca to adverse conditions is very marked. An Australian Pond-Mussel has been known to live out of water for over a year, and several Land-Snails have revived after a captivity of from two to five years without food. One of the most remarkable instances occurred in the British Museum. A specimen of *Helix desertorum*, the common Desert Snail of Egypt, was fixed on a tablet in March 1846 and was found to be alive in March 1850, having passed four years in a museum case without any food or moisture. It became torpid in October 1851 and was found to be dead in May 1852. Extremes of temperature appear to affect Mollusca less than some other animals. Thus a species of *Helix* has been said to tolerate a temperature of −120° C., and *Melanopsis parreyssii* lives at 42° C. in hot springs in Hungary.

Many Mollusca become torpid in winter in cold climates (hibernation) or in summer in hot climates (aestivation). Fresh-water and terrestrial species in these circumstances bury themselves in the soil or shelter in crevices. The period of hibernation in the British Isles varies very much according to the severity of the weather, and Land-Snails may be found emerging from their retreat in mild days in January.

Distribution.

While the Mollusca were no doubt originally marine animals, the Amphineura, Scaphopoda, and Cephalopoda are the only classes that are still confined to the sea. Some families of Gastropoda and Lamellibranchia are represented by an abundance of

Fig. 7.



Shell-bearing Pteropod (*Carolinia tridentata*). Case 96.
a, shell and animal; *b*, side view of shell; *c*, dorsal view of shell.

species in fresh water, while the Gastropoda alone have succeeded in adapting themselves to a life on dry land.

In the sea molluscs form a large part of the bottom fauna. On a sandy bottom, for example, Lamellibranchs are sometimes the only large animals brought up by the dredge. On rocky coasts in the British Isles the most obvious animals between tide-marks are the Common Limpet, the Dog-Whelk, and the Periwinkle. On tropical shores Lamellibranchs and Gastropods of large size and brilliant colours are frequently conspicuous and abundant. In the ocean Mollusca are known to extend to abyssal depths, even to 2,900 fathoms. The pelagic floating fauna (plankton) of the sea includes certain aberrant Gastropods such as the Sea-Butterflies (Pteropoda) and the Heteropoda, the former sometimes occurring in vast shoals.

On land the Stylommatophora (including the true Snails, Helicidae, and Slugs) are a remarkably numerous group. Land Mollusca have a very wide range, and their habitat includes

forests, deserts, marshes, and mountains. A species of the Slug *Anadenus* occurs at 16,400 feet in the Himalayas, but this record is surpassed by a freshwater Snail which has been found at 18,000 feet. The most northerly point at which land Mollusca have been obtained is in 72° N. lat. in South Greenland (*Vitrina angelica*).

A certain number of Gastropod and Lamellibranch genera contain exclusively brackish water species. Certain forms of *Paludestrina*, *Auricula*, and *Scrobicularia* are confined to coastal ditches, estuaries, and creeks, while the estuaries of large tropical rivers contain a special molluscan fauna. The distribution of land forms is in general determined by the amount of moisture and to a less degree by the nature of the soil and possibly by temperature. Individual species may be very rigidly limited in their distribution by obstacles to dispersal.

The Mollusca are abundantly represented in the fossil state and are found from the Lower Cambrian upwards. The Gastropoda are probably the earliest that can be recognized, but the main classes were differentiated at least as early as the Silurian epoch.

The Mesozoic era was remarkable for the great abundance and variety of the Cephalopoda (Ammonites, Belemnites, &c.). The Tertiary fauna as a whole is very like that of the present time, and a great number of existing genera originated within the era. Some are, however, much older, one of the most remarkable being the Gastropod genus *Pleurotomaria*, which is recognizable in Silurian rocks and has survived until the present day.

For a more complete account of fossil Mollusca the visitor is recommended to consult the *Guide to the Fossil Invertebrate Animals*.

Variation.

Variation among Mollusca is illustrated by some selected examples exhibited in Wall-case A and Case 135.

Variation is sometimes directly dependent on changes in the external conditions of life. Thus various Nudibranchs change their colour according to the plants or animals on which they feed, *Fiona marina*, for example, becoming greyish blue or brown according as it feeds on the Coelenterate *Velella* or the Barnacle *Lepas*.

Changes in the composition of the water may induce marked alteration in the form and shape of the shell in aquatic Mollusca. A decrease in salinity will often bring about a decrease in the thickness of the shell in *Patella*, *Buccinum*, and *Littorina*. In the relatively fresh water of the Baltic Sea the marine Gastropods *Nassa reticulata* and *Littorina rudis* are notably shorter than those in the North Sea, while the proportions of the shell in *Cardium edule* are modified by fresh water in the Sea of Aral. That excess of salinity may have a similar adverse effect upon the

shell has been shown in molluscs inhabiting lakes and lagoons. Changes in temperature may also induce various changes, e.g. in colour and in the shape of the shell. Thus the Slug *Amalia gracilis* at a constant temperature of 25° C. is yellowish brown, while it becomes black if the temperature is decreased to 10° C.

Other factors which we can distinguish with less certainty sometimes produce remarkable changes in structure. The shell of a form of *Limnaea andersoniana* found in ponds in the Shan States has a short spire, the body whorl large and swollen, and the aperture wide. Another form of the same species found in streams has a narrower shell, with the spire longer and the aperture smaller. Similar differences exist between two forms of European *Limnaea* (*L. orata* and *L. peregra*), and it is stated that it is possible to change the shell-form of the one into that of the other by transferring the eggs of *L. orata* to running water or those of *L. peregra* to still water.

While such variation appears to be the direct result of changes in environment there are others which cannot be ascribed to this cause; for instance, the diversity of colour-marking seen in certain common Snails (*Tachea nemoralis* and *T. hortensis*) (Case No. 135).

Economic Importance.

Mollusca have been used as food by man at least since the Palaeolithic period, and in every region of the world. Although the oyster is, and has been since Roman times, the most highly esteemed, several other less valuable species are very largely consumed in this country. For example, in 1922, the following quantities of edible molluscs were delivered at Billingsgate Market, London: oysters, 1,207 tons; mussels, 1,888 tons; periwinkles, 3,245 tons; whelks, 889 tons; cockles, 88 tons. (Data kindly supplied by the Fishery Department, Fishmongers' Company.)

The edible Snail is sufficiently important in France to make its cultivation a regular industry. Mollusca may also be of importance to man as the food of edible fishes; for example, Lamellibranchs form 80 per cent. of the food of the Plaice.

The most valuable commercial products furnished by Mollusca are pearls, which are obtained from the Pearl Oyster (*Margaritifera*) and a few other Lamellibranchs. An account of the formation of pearls will be found on p. 39.

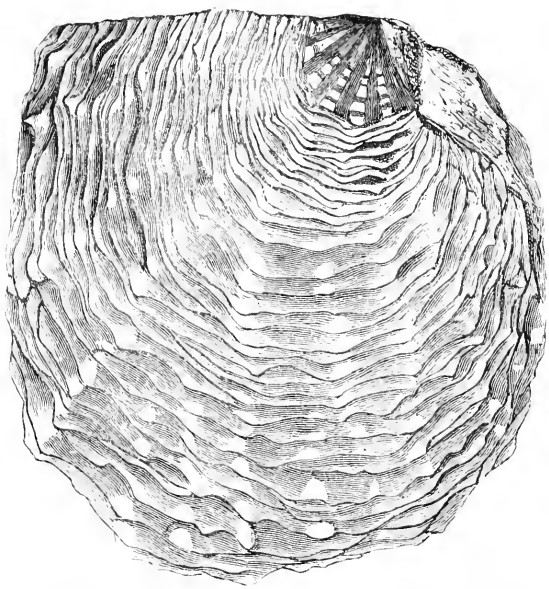
Mother-of-pearl derived from the shells of several genera of marine and freshwater Lamellibranchs is an important article of commerce for button-making and other purposes. The cultivation of many species of River Mussels (*Unionidae*) in the United States for the production of pearl shell is an industry which in recent years has assumed large proportions.

The purple dye obtained in ancient times from several species of marine Gastropods is well known, and various savage tribes at the present day employ dyes obtained from these animals.

There are many Mollusca which are directly or indirectly harmful to man. Some of these are illustrated in the two exhibits of 'Marine Boring Animals' and 'Biology of Waterworks' in the Central Hall and are described in the Guide-books to these exhibits.

The importance of slugs and snails to gardeners and other cultivators is well known.

Fig. 8.



Pearl Oyster (*Margaritifera margaritifera*). Case 147.

Some molluscs play an important part in the transmission of diseases. Certain freshwater Snails act as the intermediate hosts of Trematode parasites which infect man or domestic animals. *Fasciola hepatica*, the liver-fluke which causes liver-rot of sheep in Europe, passes part of its life in the body of the Pond-Snail *Limnaea truncatula*; and species of *Schistosoma*, Trematodes that cause serious disease in man in tropical and sub-tropical countries, similarly undergo part of their development in fresh-water molluscs (*Hypsobia nosophora* in Japan and *Isidora contorta* and *Planorbis boissyi* in Egypt).

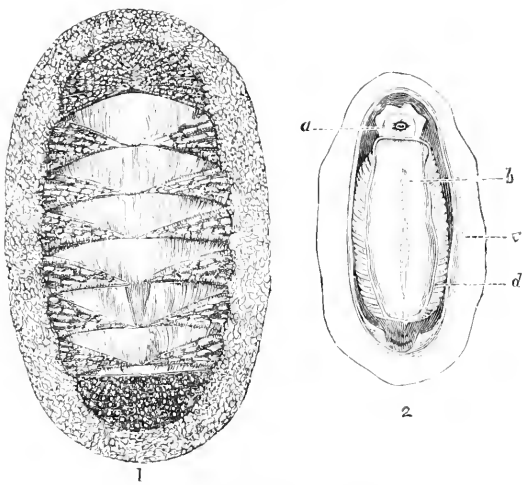
Class I. AMPHINEURA.

(*Cases* 1 *to* 3.)

These Mollusca are elongate and bilaterally symmetrical, with the head and anus at opposite ends of the body. They are all marine animals, and some of them are found at great depths. Spicules are present in the mantle. The Amphineura are divided into two orders, the Polyplacophora and the Aplacophora.

The Polyplacophora include the 'Coat-of-mail' Shells (*Chitonidae*). They are characterized by the possession of a series of

FIG. 9.



Coat-of-mail Shells, or Chitons.

1. *Chiton squamosus* (upper surface).
2. *Chiton elegans* (lower surface): *a.* mouth; *b.* foot; *c.* mantle; *d.* gills.

eight plate-like shells on the back, typically well developed and overlapping (e.g. *Chiton*) but in some genera (e.g. *Cryptoplax*, *Schizochiton*) reduced and well separated. In many forms the shells are covered over by the mantle, as in the giant *Cryptochiton stelleri* of the North Pacific. The shell is traversed by a number of fine branching canals in which are lodged peculiar sense-organs known as 'shell eyes'; these may have a retina and lens. The upper surface of the mantle may be smooth, granular, or armed with spicules. Between the foot and the mantle is a row of gills which may be nearly continuous round the body. The heart is dorsal in position and is very elongate.

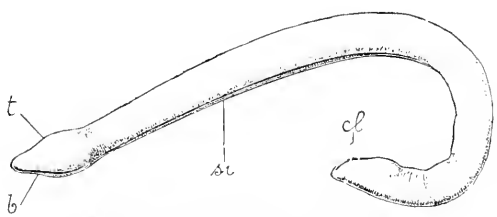
Chitons are found in all parts of the world. They live chiefly on rocks and stones in pools near low tide-mark, but a few have

been obtained from depths of over 2,000 fathoms. About 600 living species are known, including more than a dozen from British coasts.

These animals, like woodlice, have the power of rolling themselves into a ball. In some of them the eggs are incubated in the furrow between the gill and the foot ; in *Callistochiton viviparus* development is direct, and takes place in the oviduct.

The Aplacophora (Case 3) are worm-like and devoid of shells ; the mantle usually covers the body completely, a median ventral furrow remaining uncovered in *Neomenia* and its nearest allies. The foot is very much reduced in size or is absent altogether. The gills are contained in a special cavity at the posterior end of the body. These animals live on oozy bottoms, sometimes at very great depths. *Neomenia* and allied genera are usually found upon corals and Hydroids. A few species occur in British Seas.

Fig. 10.



Proneomenia gerlacheri, left side view.
b, mouth ; *cl*, cloaca ; *si*, foot groove ; *t*, head.
From Lankester's *Treatise on Zoology* (by permission of Messrs. A. & C. Black).

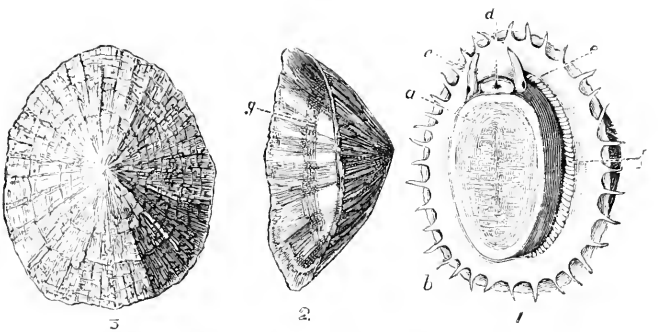
Class II. **GASTROPODA.**

(*Cases* 3 *to* 136.)

This class contains some of the most familiar molluscs, such as the Limpet, the Whelk, the Snail, and the Slug. Most Gastropods have a spirally coiled shell and a well-differentiated head region, and their internal organs are asymmetrical. During the development of the Gastropoda the original symmetry of the larva is affected by two processes known as 'ventral flexure' and 'torsion'. As a result of these the anus, which was originally posterior, becomes anterior and ultimately reaches a position above the mouth, the visceral commissure of the nervous system is twisted into a figure of eight, and certain organs of the original left side tend to atrophy and may disappear. There are many Gastropods in which the visceral commissure is untwisted, and some of these are symmetrical and have the anus in its original posterior position ; but they have only one auricle of the heart, and one kidney, and it seems clear that their apparently primitive

features are really secondary. The Gastropoda are divided into two sub-classes, the Streptoneura, in which twisting of the visceral commissure is well marked, and the Euthyneura, in which untwisting has taken place. In the Streptoneura the nervous ganglia are relatively little concentrated, whereas in the Euthyneura they are, as a rule, much concentrated in the head region. A structure present in most Streptoneura, but in only a few Euthyneura, is the operculum, a hard plate borne on the upper surface of the foot, serving to close the aperture of the shell when the animal is withdrawn. In the majority of the Streptoneura the sexes are separate, but all Euthyneura are hermaphrodite.

Fig. 11.



The Common Rock-Limpet (*Patella vulgata*). British.

1. Animal: *a.* foot; *b.* fringed mantle; *c.* tentacles; *d.* mouth; *e.* eyes; *f.* gills.

2. Side view of shell, showing the impression or scar of the attachment-muscle, *g.*

3. Upper surface of the shell.

Sub-class I. STREPTONEURA.

Order 1. **ASPIDOBRANCHIA.**

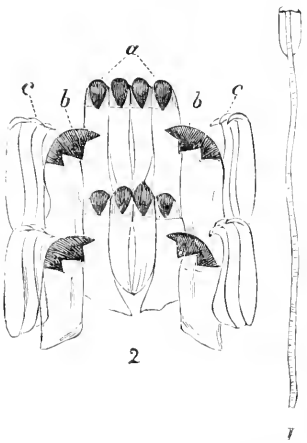
(*Cases* 3 *to* 20.)

This order includes Gastropods with paired auricles of the heart, paired kidneys, and occasionally paired gills, and with the gill-filaments set on opposite sides of a main axis. The first sub-order, the Docoglossa, is so called because the teeth of the radula have the shape of beams. It includes the Limpets (*Acmaeidae* and *Patellidae*), in which the shell is not spirally coiled.

The Acmaeidae are called 'false Limpets', because, although their shells are similar to those of the true Limpets, they have a single true gill, whilst the Patellidae have false gills greatly developed as outgrowths of the mantle all round the sides of the

foot. Both the true and false Limpets are littoral and are found on rocks between tide-marks. They have the power of excavating the surface to which they attach themselves, the secretions of the disk-like foot dissolving away the rock to form a shallow pit, to which the animal is known to return with great constancy. The largest known Limpet (*Patella* (*Ancistromesus*) *mexicana*, Case 7) inhabits the west coast of Central America, its shell having sometimes a length of 12 inches. The Limpets are vegetable feeders and live on seaweeds of various kinds, which they rasp with their radulae. That of the Common English Limpet (*P. vulgata*, Fig. 12)

Fig. 12.



1. Radula of the Common British Rock-Limpet (*Patella vulgata*), natural size.
2. Two transverse series of teeth: *a*. median teeth; *b*. laterals; *c*. uncini or marginals.

Fig. 13.

Pleurotomaria adansoniana. Case 9. ½ natural size.
From *The Cambridge Natural History*, by permission of Messrs. Macmillan & Co.

is longer than the shell itself, and is armed with as many as 1,920 hooked teeth in 160 rows of twelve each. The Limpet is commonly used for bait in the sea-fishing off the Scottish coast. Some Limpets, such as *P. compressa*, *P. mytilina*, &c., are found on the stems of floating seaweeds, and have the shells usually thinner and smoother than the Rock-Limpets, which have to resist the fury of the breaking waves.

The second sub-order, the Rhipidoglossa, is so called because the teeth of the radula are arranged like a fan. It includes the remaining Aspidobranchia.

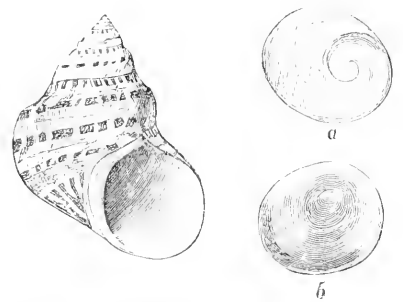
The 'Keyhole Limpets' and 'Slit Limpets' (*Fissurellidae*) resemble in external shape ordinary Limpets, but have the shell

perforated at or near the apex, or more or less slit at the front margin. The hole or slit gives passage to a tubular orifice of the mantle, through which excreta and water used for respiration escape. The largest species are from California and South America.

The *Pleurotomariidae* are extremely rare in recent times, only six species being known, whereas over a thousand fossil forms have been described.

The 'Ear-shells' or 'Ormers' (*Haliotidae*) are found adhering to rocks in most parts of the world, with the exception of South America. Like the Limpets they hold on to the rocks with great tenacity. The shells are lined with mother-of-pearl, and many exhibit splendid colours and sculpture. The shell of *Haliotis* is pierced by a series of holes parallel with the left margin; through these the animal protrudes slender tentacles. *Haliotis tuberculata*

Fig. 14.



Top-shell (*Turbo petholatus*). (From the Indo-Pacific Ocean.)
a. Inner surface of operculum; *b*. exterior of ditto.

is common on rocks and stones at low water in the Channel Islands and the North of France, where it is frequently eaten; other species in New Zealand, China, Japan, West Africa, and elsewhere, constitute a common article of diet. *Haliotis* shells are largely used in the manufacture of pearl ornaments, and in all kinds of inlaid work.

The *Trochidae* and *Turbinidae* are two extensive families mainly distinguished by the operculum, which is horny in the former, and shelly in the latter. The shells of these molluscs are pearly within, and are generally brightly coloured and highly ornamented. Several very pretty species are found on our own shores.

Of the *Neritidae* the species of *Nerita* are mostly found in tropical countries, and like the Periwinkles have very strong shells to resist the force of the breaking waves. *Neritina* includes both marine and freshwater species, which have less solid shells. The shell of *Septaria* is shaped very much like those of Limpets, except that the apex is at one end instead of central.

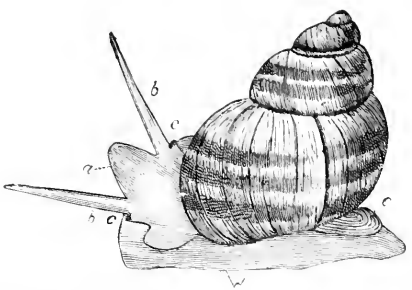
Order 2. **PECTINIBRANCHIA.**

(*Cases 22 to 94.*)

This order includes Streptoneurous Gastropods with only one auricle, one kidney, and one gill. The gill has lost the filaments of one side, by which it is attached to the mantle. In the first sub-order, the Taenioglossa, the radula has usually several teeth in each row. This sub-order includes a large number of families (*Viviparidae* to *Carinariidae*).

The 'River-Snails' (*Viviparidae*) are rather sluggish, and are found at the bottom of ponds and rivers feeding on decaying animal and vegetable matter. The common British species is *Viviparа viripara*, the female of which rears the young in a brood pouch at the end of the oviduct.

Fig. 15.



The Common British River-Snail (*Viviparа viripara*).
a. head; *b*. tentacles; *c*. eyes; *d*. foot; *e*. operculum.

The *Cyclophoridae* and *Cyclostomatidae* are Land-Snails with the mantle-cavity converted into a lung. Some have remarkable devices for admitting air to the lung when the operculum is closed, e.g. the siphonal notch and groove in *Cataulus* (Case 24).

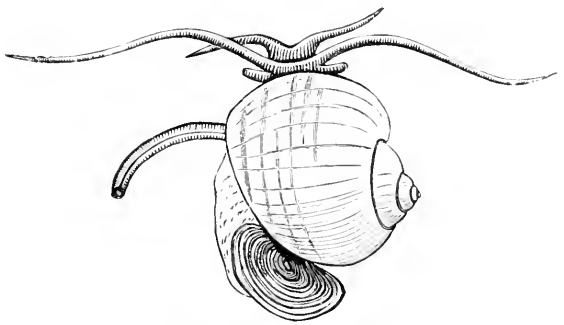
The 'Apple-Snails' (*Ampullariidae*) live in the rivers and marshes of tropical regions, and, although represented by a large number of species, exhibit comparatively slight variation in form and colour. In this family a gill and a lung occur together, and the latter can be used for respiration under water by means of a long siphon which can be protruded upwards into the air.

The 'Periwinkles' (*Littorinidae*) are found almost on every known shore; they feed upon all kinds of marine vegetation. Some species are met with at low-water mark, others on rocks almost beyond the reach of the sea, and some have been discovered inland nearly half a mile away from the shore.

The family of *Calyptraeidae* includes the 'Slipper-Limpets'

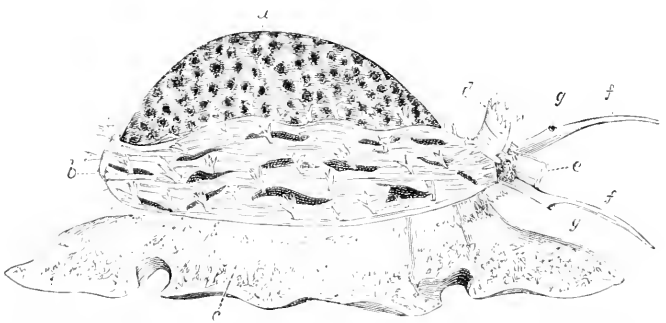
(*Crepidula*) and the 'Cup-and-saucer Limpets' (*Crucibulum*). They rarely crawl about, but remain attached to rocks, stones, or other shells, sometimes forming a shelly plate under the foot by which they become fixed to the spot where they have taken up their abode. The American *Crepidula fornicata* has established

Fig. 16.



Ampullaria canaliculata.

Fig. 17.

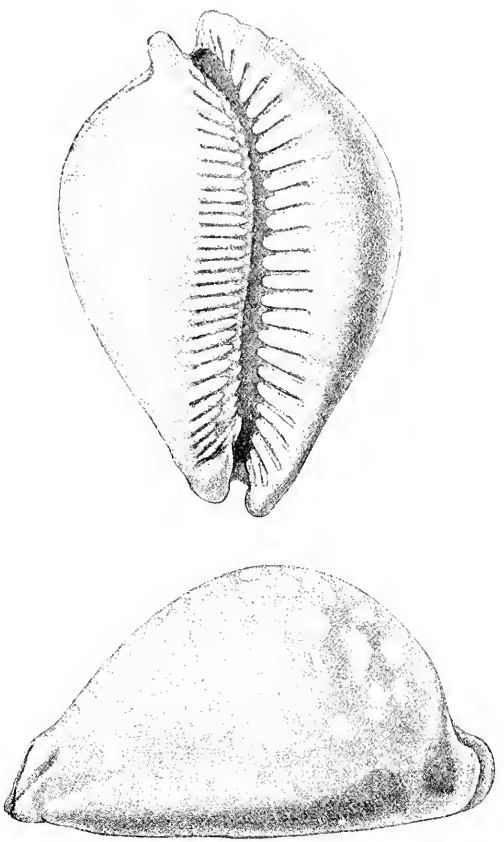


The Tiger Cowry (*Cypraea tigris*). (From the Indo-Pacific Ocean.)
a. the shell; *b*. the mantle; *c*. foot; *d*. siphon; *e*. proboscis; *f*. tentacles; *g*. eyes.

itself on the coasts of England to the great disturbance of Oyster culture. The Slipper-Limpet multiplies very rapidly and encrusts the Oyster-beds, intercepting the normal food of the Oysters. These animals settle down in clusters one on top of another (Case 31). In the individuals composing such strings there is a change of sex, the oldest (at the bottom) being females, the intermediate ones hermaphrodite, and the youngest (at the top) males.

The 'Cowries' (*Cypraeidae*) are remarkable for their varied markings and splendid polish, which is produced and preserved by two flaps of the mantle, one on each side, which fold over the

Fig. 18.



Cypraea leucodon. Case 32.

shell, a line down the centre of which usually marks where the flaps meet. The animals are even more brilliantly coloured than the shells. Cowries, as is well known, are sold as ornaments; and a small yellow species, 'the Money-Cowry' (*C. moneta*), which is very common in the Indian and Pacific Oceans, passes current as coin among the negro tribes of certain parts of Africa.

The 'Orange-Cowry' (*Cypraea aurantium*) is worn by chiefs in the Friendly Islands, and is considered the highest order of dignity. Only one small species, *Trivia europaea*, is found on the British coasts.

Of the *Ovulidae*, the most curious is the 'Weaver's-shuttle' (*Radius volva*), in which the shell is peculiarly beaked at both ends. It is found living on Gorgonian corals (*Gorgoniidae*), and some of the smaller species exhibit differences of coloration, resembling the tints of the corals upon which they are found.

The *Lamellariidae* (Case 37) live on or embedded in Tunicates, in which they deposit their eggs; the shell is more or less completely covered over by the mantle.

The 'Violet Snails' (*Ianthinidae*) are found floating about in every ocean, excepting in cold regions, with the spire of the shell downwards. They feed upon Jellyfish, and secrete a gelatinous raft, filled with air-bubbles, to the underside of which the eggs are attached.

The *Melaniidae* are freshwater Snails which abound in most tropical and subtropical countries. They are mostly of dark colours, and are found in muddy places.

The *Cerithiidae* are chiefly marine forms, some, however, entering brackish water. About five hundred fossil species have been described, some of them gigantic in comparison with any now living.

The three families *Pyramidellidae*, *Eulimidae*, and *Entochonchidae* are known as the Aglossa, as they have no radula. Most of the *Eulimidae* and all the *Entoconchidae* are parasitic on Echinoderms, and some are very degenerate in structure.

The 'Worm-shells' (*Vermetidae*) are a very peculiar family. Their shells can scarcely be distinguished from the shelly tubes which are formed by certain species of marine worms (e.g. *Serpula*, &c.). They are free and spiral in early life, but afterwards become partly 'unwound' and generally attached to rocks, stones, &c. Sometimes they form large encrusting masses.

The 'Screw-shells' (*Turritellidae*) have elongate, tapering shells. *Turritella communis* is found on the British coasts.

The *Xenophoridae* have the singular habit of cementing to the exterior of their shell stones, pieces of coral, and fragments of other shells; hence they have been called 'Carrier-shells', and, according to the kind of material chosen, have been named 'Conchologists' and 'Mineralogists'. Beyond acting as a disguise, and consequently as a protection, there does not appear to be any special utility in thus adding to the weight of their own shells. The animals do not glide like other molluscs, but scramble along.

The 'Wing-shells' (*Strombidae*) do not crawl like most other Gastropods, but progress by a sort of jerking movement or by

vigorous leaps. They act as scavengers, feeding on decomposing animal matter.

Strombus gigas, or 'the Fountain-shell', occurs in great numbers in the West Indies, and is a very heavy solid shell. At one time it was used for cameo-carving and was also employed in the manufacture of porcelain, as many as 300,000 shells having been imported into Liverpool in one year for that purpose.

The Scorpion-shells (*Pterocera*), or 'Spider-claws', as they are sometimes called, possess singular claw-like projections, which are developed on the outer lip of the shells.

The 'Trumpet-shells' (*Cymatiidae*) have strengthening ribs at intervals, like the Murices; the largest species, *Cymatium variegatum*, is used by South Sea Islanders as a horn or trumpet. A hole is made in the upper part of the spire to blow through, and the sound produced can be modulated or varied by inserting the hand in the aperture or mouth of the shell.

Fig. 19.

Scala scalaris. Case 44.

The 'Helmet-shells' (*Cassididae*) were used for cameo-carving; they consist of different layers, so that the ground colour of the carving is of a different tint from the subject engraved.

The 'Tun-shells' (*Doliidae* or *Tonnidae*) are remarkable for the globoseness of the shells, which are covered with very regular ribs.

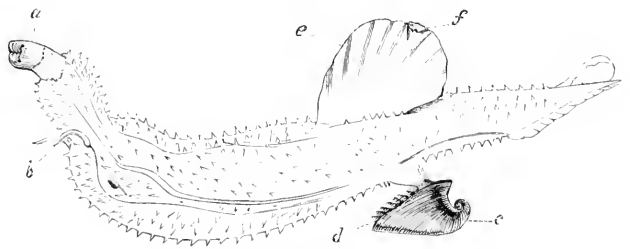
The *Atlantidae*, *Pterotracheidae*, and *Carinariidae*, at various times recognized as forming a distinct sub-class or an order of Gastropoda, under the name of Heteropoda, are now regarded as specialized Taenioglossa organized for swimming in the open sea, the foot being compressed to form a sort of fin. The Atlantas are found in great numbers in warm and temperate latitudes, and are provided with a thin, flat, spiral shell. The shell of *Carinaria* is one of the most beautiful structures of any mollusc; the animal is large, semi-transparent, and elongate. Species of this genus are found in the Mediterranean and warmer parts of the Atlantic and Indian Oceans. They feed on Jellyfish of various kinds, and probably on other soft-bodied animals.

The remaining families constitute the second sub-order of the Pectinibranchia—the Stenoglossa. In these the mouth is at the end of a protractile proboscis, and the radula has only two or three teeth in each row; these are, however, strong and often heavily serrated.

The *Fasciolariidae* contain two of the largest living Gastropods: *Megalatractus aruanus*, from North and West Australia, and *Fasciolaria gigantea*, which is found off the coast of South Carolina, and attains at times a length of 2 feet.

The *Mitridae* are great favourites with shell-collectors on account of their beautiful colours and varied sculpture. Shells of this group, like the *Fasciolariidae*, are distinguished by a few plaits or folds on the inner side of the aperture (the columella). They are almost exclusively found in tropical or sub-tropical

FIG. 20.



Heteropod (*Carinaria lamarcki*).
a. proboscis; *b*. tentacles; *c*. shell; *d*. gill; *e*. foot; *f*. sucker.

regions, the majority being met with either at low-water mark or in comparatively shallow water.

The *Buccinidae* also contain a very large and varied assemblage of forms. Among them may be mentioned the Whelks (*Buccinum*).

The family of *Muricidae*, or 'Rock-shells', contains many very handsome and peculiar forms. They are all carnivorous, feeding chiefly on other Mollusca, boring through the shells of Lamellibranchia and slowly devouring the inhabitants piecemeal. The shells of *Murex* produce at intervals ribs, which in some species are ornamented with long spines or foliations. From certain species of *Murex* (*M. brandaris*, &c.) found in the Mediterranean was manufactured the celebrated Tyrian dye.

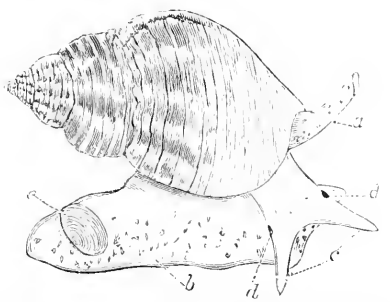
The *Purpuridae* are found between tide-marks all over the world. The *Coralliophilidae* are sedentary, living on or in corals. In *Magilus*, which in its early spirally coiled stage settles down on a coral (*Meandrina*), the aperture of the shell grows into an elongate tube, in order to keep pace with the growth of the coral.

The *Volutidae* are much sought after by shell-collectors; some of them attain to a very large size. They are found chiefly in the warmer parts of the Atlantic and Indo-Pacific Oceans, and occur in the greatest variety on the coasts of Australia.

The *Olividae* are common in most tropical seas; their shells are remarkable for their beautiful polish and various patterns of colouring. They burrow in sand in quest of bivalves for food, and some species are said to have the power of swimming by expanding the lobes of the foot.

The *Harpidae* form a small, well-marked group. The animals as well as the shells are brightly coloured. They have the remarkable power of casting off a portion of the foot when disturbed. The species are known from the Indo-Pacific Ocean, the west coast of Central America, and West Africa.

Fig. 21.



The Common Whelk (*Buccinum undatum*).
a. siphon; *b*. foot; *c*. tentacles; *d*. eyes; *e*. operculum.

The next family, the *Pleurotomidae* or *Turridae*, consists of very numerous species, over a thousand living forms having been discovered, and almost as many fossil species from Cretaceous and Tertiary strata. The typical forms are characterized by a slit in the outer side (lip) of the aperture. Species of *Pleurotoma* are found in every sea, although most abundant in the tropics.

The 'Auger-shells' (*Terebridae*) have a great diversity of external ornamentation. They are all elongate shells, with a deep notch at the base of the aperture.

The *Conidae*, or Cones, are found in all tropical seas. This family, of which between 400 and 500 distinct kinds are known, is a great favourite with collectors on account of the brilliant colours and various patterns of the shells. They are all carnivorous, and live usually in shallow water among rocks and coral-reefs. They possess a poison-gland, and several species are recorded as having inflicted poisonous bites, often with serious results.

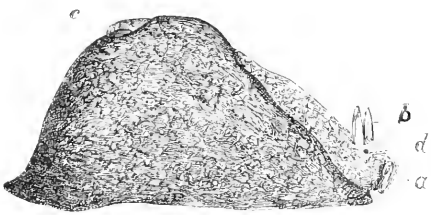
Sub-class 2. EUTHYNEURA.

The Gastropods belonging to this sub-class, with few exceptions, have the visceral nerve-loop uncrossed. All the Euthyneura are hermaphrodite, and their radula is generally composed of numerous similar denticles on each side of a median tooth. Scarcely any are provided with an operculum in the adult state. The Euthyneura may be divided into two orders, *Opisthobranchia* and *Pulmonata*.

Order 1. **OPISTHOBRANCHIA.**

All the molluses of this order are marine, some (*Tectibranchia*) breathing by means of the ordinary Gastropod gill (ctenidium), which is generally behind the heart, whereas others (*Nudi-*

Fig. 22.



Sea-Hare (*Tethys* (*Aplysia*) *punctata*). British.
a. labial tentacles; *b*. upper tentacles or rhinophores; *c*. siphonal fold of the mantle near the shell; *d*. eye.

branchia) have lost the true gill and have developed a different type of respiratory organ.

The *Tectibranchia* include the 'Bubble-shells' (*Bullidae*), the 'Sea-Hares' (*Aplysiidae*), the 'Umbrella-shells' (*Umbraculidae*), the 'Pteropods', formerly considered a distinct class, and some others. In the more primitive types (e.g. *Actaeon*, *Scaphander*, *Bulla*) the shell is well developed and untwisting of the visceral nerve loop is incomplete; in others the shell may be reduced or absent.

The Pteropods, sometimes called Sea-Butterflies, comprise two groups, Pterota and Eupteropoda,[1] which are organized for swimming freely in the ocean. They have a pair of fins developed from the sides of the foot. The Eupteropoda are provided with small glassy shells; the Pterota are naked. Pteropods may constitute an important part of the food of the Baleen Whales.

[1] The union of these two groups under a single name, though convenient for several reasons, is not justifiable systematically. The Eupteropoda are more correctly classified with the *Bulla*-like forms and the Pterota with *Aplysia* and its allies.

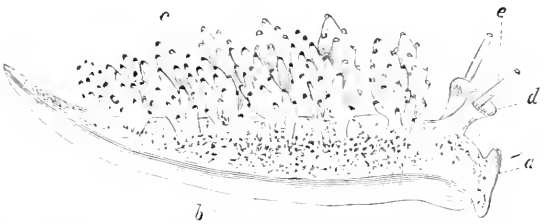
They exist in countless millions in some parts of the ocean, discolouring the water for miles. In certain regions the bottom of the ocean, in depths between 1,000 and 2,000 fathoms, is covered by a thick ooze formed from their shells.

The Sea-Hares, so called on account of a slight resemblance to a crouching hare, are found in most parts of the world. At the hinder part of the back two flaps of the mantle partly conceal a thin horny shell which serves as a protection to the gills and vital organs beneath. When molested, these animals discharge a large quantity of a purple fluid, discolouring the surrounding water for a distance of more than a yard.

The remarkable shell of *Umbraculum* is shaped very like a Chinese umbrella.

The *Nudibranchs* or Naked-gilled Molluscs comprise some of the most beautiful and strange forms. They are unprovided with

Fig. 23.



Naked-gilled Mollusc, or Nudibranch (*Doto coronata*).
a, head; *b*, foot; *c*, dorsal papillae; *d*, tentacle-sheath; *e*, tentacle.

shells except in the earliest stages of their existence, when they have a minute coiled (and often nautiloid) shell, furnished with an operculum, both of which are subsequently cast off. Some of them bear on the back a series of appendages, often fantastically shaped. Unfortunately the colours of these beautiful creatures cannot be preserved after death, and therefore a small series of glass models is exhibited, which will give some idea of their great variety in form and colouring. They are found in most parts of the world, chiefly in shallow water, but a few species live upon floating seaweed in the open sea. Over a hundred species exist on the British coast, the majority of which are, however, very small. They are chiefly carnivorous, feeding on other molluscs, Sea-Anemones, &c.

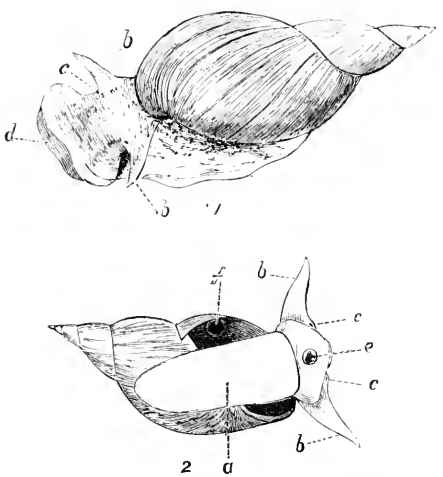
Order 2. **PULMONATA.**

(*Cases* 97 *to* 135.)

The *Pulmonata* are Euthyneura in which the mantle-cavity is converted into a lung. There is no true gill, but in certain aquatic

forms gill-like structures may be developed in the mantle-cavity. Most *Pulmonata* are provided with shells, but, with the exception of the *Amphibolidae*, the adults never possess an operculum. The majority are terrestrial, but some are aquatic and there are a few marine forms. They are divisible into two sub-orders, *Basommatophora* and *Stylommatophora*, characterized by the difference in the position of the eyes. The *Basommatophora*, including the *Auriculidae*, *Amphibolidae*, *Siphonariidae*, and *Limnaeidae*, have a single pair of tentacles, at the base of which the eyes are situated. The *Stylommatophora* (Land-Snails, Slugs, &c.) are

Fig. 24.



British Pond-Snail (*Limnaea stagnalis*).
1. Upper view: *a.* foot; *b.* tentacles; *c.* eye; *d.* muzzle.
2. Lower view: letters *a. b. c.* as above; *e.* mouth; *f.* respiratory orifice.

provided, save in a few cases, with two pairs of retractile tentacles, with the eyes at the summit of the hinder pair. Over 10,000 species of *Pulmonata* are known.

Sub-order 1. **Basommatophora.**

The *Auriculidae* chiefly inhabit salt or brackish water. The largest forms are tropical and found at the mouths of rivers, among the roots and stems of mangrove-trees, or in damp wood near the sea.

The 'Limpet-Snails' (*Siphonariidae*) look very like true Limpets, but their shells are distinguished by a slight bulging on one side, caused by a groove on the inside which lodges a respira-

tory siphon. They are marine, and are found on rocks between tide-marks, chiefly in tropical countries.

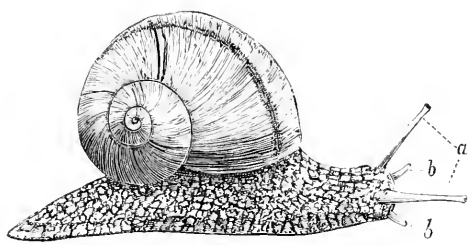
The *Limnæidæ* are found only in fresh water. Most of them occasionally rise to the surface to breathe, where they glide along foot uppermost, at times suspending themselves by a glutinous thread, after the fashion of a spider. *Limnæa stagnalis* is the common Pond-Snail of Britain.

The freshwater Limpets (*Ancylidæ*) live attached to stones and leaves of plants. Like the *Limnæidæ* they feed on freshwater algæ, confervæ, and decayed vegetable matter.

Sub-order 2. **Stylommatophora.**

With the exception of the cosmopolitan marine family *Onchidiidæ* these Pulmonates are terrestrial.

Fig. 25.



British Land-Snail (*Helix pomatia*).
a. eye-bearing tentacles; *b*. lower or smaller tentacles.

True Snails (*Helicidæ*, *Bulimulidæ*, *Stenogyridæ*, &c.) are nearly all protected by a spiral shell. They are almost exclusively vegetable feeders, subsisting chiefly on leaves. Many of the species are beautiful objects on account of the brilliancy of their coloration, and some are remarkable for the variation they exhibit in this respect. Species of *Helicidæ* are found in nearly every part of the world and in all situations, from sea-level to an altitude of 12,000 feet. They are fond of moisture, and in hot and dry weather retire within their shells, remaining torpid until the return of dew and rain. *Helix pomatia* (Case 119) is commonly eaten in Austria, France, and Belgium.

The eggs of Land-Snails vary in texture and size; they are usually white, but in some instances yellow and pale green. Those of some of the large South-American forms are as hard as that of a hen, and more than an inch in length (Case E).

Slugs (Case 106) are anatomically very like Snails, but possess no external shell; most of them, however, have a small internal shelly plate, or a few calcareous granules hidden beneath the

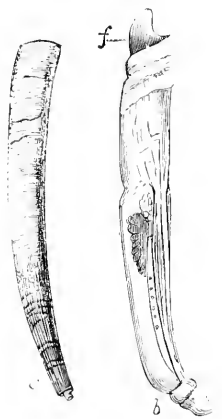
skin of the back. Some have a large slime-pore at the end of the foot, and others are slightly phosphorescent. Like the Snails, they are fond of damp localities, and at times become great pests owing to the damage they do to field and garden crops of all kinds. *Testacella*, which is found in this country, differs from the Slugs in having a small external shell at the posterior end of the body. It is not slimy, and lives underground, feeding upon earthworms.

Class III. SCAPHOPODA.

(*Case* 136.)

This class consists of but two families—the *Dentaliidae* and *Siphonopodidae*. These are marine molluscs with an elongate

Fig. 26.



British Tooth-shell. (*Dentalium tarentinum.*)
a. the shell; *b*. the animal, removed from its shell; *f*. the foot.

body and tubular shell. The edges of the mantle are united under the foot, forming a tube which, like the shell, is open at both ends. The head bears two lobes which carry numerous filaments; these are sensory and prehensile in function. The foot is capable of considerable extension and the animal digs itself into the sand with it.

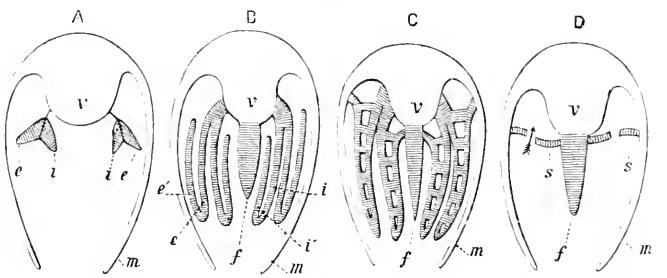
The shell is shaped rather like an elephant's tusk and its larger orifice is at the anterior or head end. The smaller posterior orifice is usually kept out of the sand or mud when the animal is burrowing. Scaphopods are found in all seas, there being seventeen British species. They are found at all depths down to 2,500 fathoms. *Dentalium* and *Cadulus* are the most characteristic genera (Case 136).

Class IV. LAMELLIBRANCHIA.

(*Cases* 137 *to* 204.)

The Lamellibranchs, or Bivalves, include the Oysters, Cockles, Mussels, &c. They have no jaws and no radula, and the head and its associated sense-organs are little developed. The body is enclosed between two deep lobes of the mantle which secrete a bivalve shell, the two halves of which are connected by a horny elastic structure, the ligament, and, in addition, are usually articulated together by a series of interlocking 'teeth'. The closing of the valves is effected by a pair of *adductor muscles*, sometimes reduced to one. When the muscles relax, the valves

Fig. 27.



A. Protobranchia; B. Filibranchia; C. Eulamellibranchia; D. Septibranchia. *m*. mantle; *v*. body; *f*. foot; *c*. outer gill-lamella; *i*. inner gill-lamella; *e'*. reflected portion of outer lamella; *i'*. reflected portion of inner lamella; *s*. gill modified to form a septum.

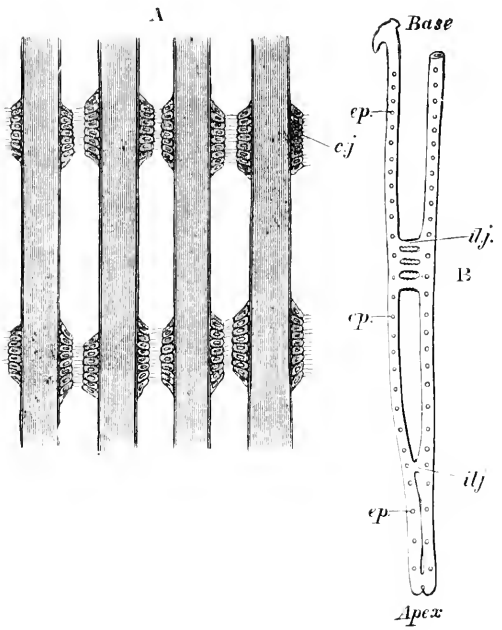
From *The Cambridge Natural History* (by permission of Messrs. Macmillan & Co.).

gape as a result of the elasticity of the ligament. In many Lamellibranchs a special gland in the foot secretes the byssus, a bundle of hard threads that serve to fix the animal down on the bottom. The Lamellibranchia are all aquatic and most of them are marine. They usually burrow in sand or mud, or may be permanently fixed; some (*Teredo*, *Pholas*, &c.) excavate burrows in wood or stone. A few crawl about (e. g. *Cyclas*) or progress by short leaps (e. g. *Tellina*) or swim by abruptly opening and closing the valves of the shell (e. g. *Lima*, *Pecten*). They do not seek their food, but live on microscopic organisms and organic débris, which are swept towards the mouth by the cilia on the gills.

The Lamellibranchs are very uniform in structure, and this makes them very difficult to classify; the most satisfactory system is based on the modifications of the gills, which are suspended between the body and the mantle-lobe, one on each

side. Each gill consists of an axis that is partly attached and of two series of filaments. In the most primitive forms (*Protobranchia*) the series of filaments are divergent, but in the majority (*Filibranchia*, *Eulamellibranchia*) they are nearly parallel, with each individual filament bent into a proximal (descending) and a distal (ascending) portion. Further complication results from the

Fig. 28.



Gill of *Mytilus edulis*.

A. Part of four filaments showing ciliated interfilamentar junctions (*c.j*).

B. Diagram of a single filament showing the two lamellae connected at intervals by interlamellar junctions (*il.j*) and the position of the interfilamentar ciliated junctions (*ep*).

From the *Encyclopaedia Britannica* (by permission of Messrs. A. & C. Black).

formation of junctions between adjacent filaments, so that each series of filaments becomes a double lamella, from the development of interlamellar connexions and from extensive folding of the lamellae themselves. In one group (*Septibranchia*) the gills are reduced to a muscular septum.

Four orders may be recognized, *Protobranchia*, *Filibranchia*, *Eulamellibranchia*, and *Septibranchia*.

Order 1. **PROTOBRANCHIA.**

(*Case* 137.)

In the *Protobranchia* the individual filaments of the gills are not doubled, and are arranged on their axis in two divergent rows. The gills thus have essentially the same structure as those of the Polyplacophora and the Rhipidoglossa. The foot is flattened underneath (another primitive character), and the byssus is but poorly developed. There are only a few families of living forms, of which the *Nuculidae* (Case 137) are the best known. A number of fossils, chiefly from the Silurian, have been referred to this group on the evidence of the shell.

Order 2. **FILIBRANCHIA.**

(*Cases* 137 *to* 153.)

To the *Filibranchia* belong some familiar molluscs, such as the Scallop and Mussel. In these Lamellibranchs the two rows of filaments in each gill are parallel to each other and their ends are 'reflected', i. e. the filaments are bent on themselves so as to make a narrow V. Each series of filaments, from the gill-axis to the bend, is named the descending lamella, and from the bend to the tip the ascending lamella. The adjacent filaments are locked together by tufts of cilia which fit into each other like two hair-brushes pressed together by their bristles. The foot usually exhibits a well-developed byssus.

The *Anomiidae* are remarkable for a deep notch in the right valve, through which the byssus passes when the animal is fixed down. The *Placunidae* (Case 138) have a very flat pearly shell and a unique hinge consisting of two long divergent teeth. The young shells are so transparent that they have been largely used in the East for glazing windows.

The *Arcidae* have strong ponderous shells with numerous small teeth in the hinge-line. A few of the smaller species live on corals.

The *Trigoniidae* (Case 141) include a few living species from Australia and more than a hundred forms from Jurassic and Cretaceous strata.

The Mussels (*Mytilidae*, Cases 142–145) are well known. The byssus is usually well developed; with it the animals attach themselves to rocks or to one another, often forming large colonies. The coloration of certain *Mytilidae* is very attractive, rich brown and green being the prevailing hues (cf. Case 143). The species of *Lithodomus* are not fixed down by a byssus, but burrow into coral and limestone.

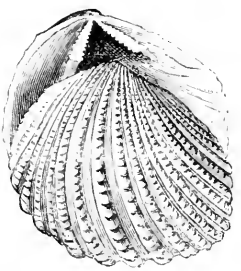
Inoceramus, found fossil in the Jurassic and Cretaceous, is remarkable for its gigantic size. A species obtained in Nebraska

measures over a yard in diameter. A large specimen may be seen in the Geological Department.

The *Pteriidae* include the 'Pearl' and 'Hammer' Oysters and the Wing-shells. The Hammer Oysters (*Malleus*, Case 146) are remarkable for the grotesque shape of the shell, an exaggeration of a tendency seen in *Avicula* (Case 145), *Pteria*, and certain species of *Margaritifera*. *Avicula zebra* lives on a Hydroid, *Halicornaria insignis*, and imitates its colour-markings with remarkable closeness.

The Pearl Oysters (*Margaritifera*) are exhibited in Case 147 and Wall-case D. Species of this genus occur on the coasts of India, Ceylon, and North-West Australia. In the Ceylon pearl fishery 80,000,000 shells were dredged in 1905. The interior of the shell of these molluscs is lined with dense nacre or mother-

Fig. 29.



Trigonia margaritacea. Case 141.
From *The Cambridge Natural History* (by permission of Messrs. Macmillan & Co.).

of-pearl (v. p. 9), and the isolated pearls found in the tissues of the animal are formed of the same substance. The most important types of pearl are the 'orient' and 'musele' pearls. Orient pearls are by far the most valuable; they are often formed round a parasitic worm that has found its way into the tissues of the mantle. Round this centre of irritation are built up successive layers of nacre until an irregular or spherical body is formed. Sometimes the pearl contains another sort of nucleus, e. g. a sand grain. Muscle pearls, which are usually found in the neighbourhood of muscles, do not contain a nucleus of intrusive substance, but are formed round particles of nacre. Such is the origin of most of the small seed-pearls. The well-known Japanese 'culture pearls' are produced by grafting into the mantle of a Pearl Oyster small pieces of the mantle epithelium of another individual, each wrapped round a small piece of nacre, which serves as a nucleus. 'Blister pearls', which are of no commercial value, are found on the inner surface of the shell. These result from the intrusion of

foreign bodies between the mantle and the shell, or are secreted over areas invaded by boring animals such as Sponges (*Cliona celata*) and worms.

The Chinese obtain pearls artificially from a species of fresh-water Mussel (*Dipsas plicata*). In order to do this they keep them in tanks and insert between the shell and the animal either small shot or small round pieces of mother-of-pearl, which soon receive regular coatings of nacre and assume the appearance of ordinary pearls. They also insert small metal images of Buddha, which also soon become covered with pearl and firmly cemented to the shell. Specimens illustrating this practice, as well as shells of the Ceylon Pearl Oyster containing small fish and crabs coated over with nacre, are exhibited in the Pearl Oyster Series (Wall-case F).

The *Spondylidae*, or Thorny Oysters, closely resemble the Scallops, but their shells are heavier, more spiny, and united by interlocking teeth; many are very brightly coloured. The *Pectinidae*, Scallops or Fan-shells, are well known for their beautiful colours and sculpture. The eyes, which are borne on the mantle, approach the Vertebrate eye in complexity. The young move through the water by opening and shutting their valves. The species are numerous and are found at all depths.

Order 3. **EULAMELLIBRANCHIA.**

(*Cases* 153 *to* 204.)

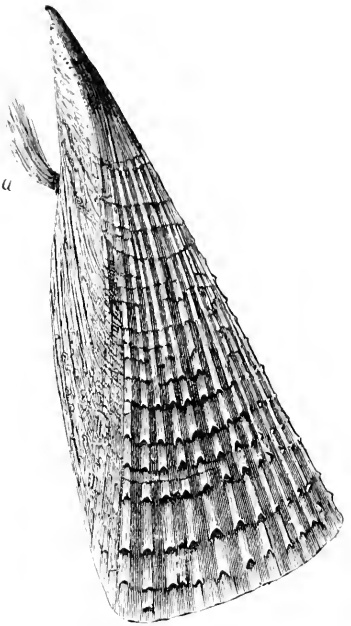
The *Eulamellibranchia* have the gill-plates joined together by vascular interlamellar junctions and very much folded. The edges of the mantle are united at one or two points.

The Oysters (*Ostraeidae*, Case 154) are the most familiar members of this order; since early times the cultivation of these animals has been practised in various parts of the world. A series of shells of different ages from the 'spat' to the adult is shown in Case 154. During the months of May, June, and July, the eggs are discharged into the gills, where they remain until hatched; during this period and until the eggs are hatched in September, Oysters are 'out of season'. The Common Oyster passes through a sexual cycle to which reference has been made already (p. 12).

The Japanese *Ostraea gigas* is said to grow to a length of 3 feet, and some species of *Pinna* reach a length of 2 feet. The latter are found embedded in sand with the pointed end downwards. The threads of the large silky byssus can be used for weaving or knitting.

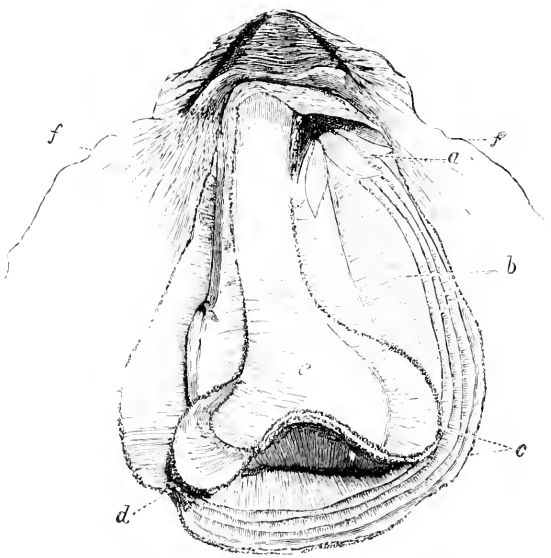
The *Carditidae* and *Astartidae* (Cases 160, 161) have strong, solid shells, frequently ornamented with radiating or concentric ribbing, and usually coated with a dark epidermis. They have the general appearance of certain *Veneridae*; the animal has no

Fig. 30



British 'Fan-Mussel' (*Pinna pectinata*): *a*. the byssus; Case 157.

Fig. 31.

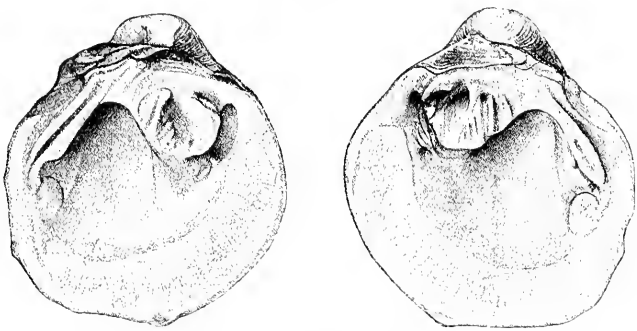


Common Edible Oyster (*Ostrea edulis*).
a. labial palpi; *b*. gills; *c*. mantle; *d*. junction of the two folds of the mantle: *e*. large adductor muscle; *f*. the shell.

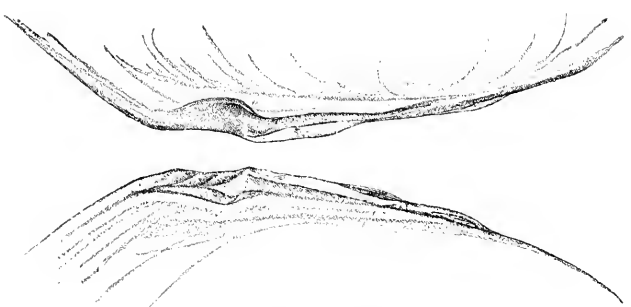
prolonged siphons, but merely a fringed opening in the mantle One very remarkable species, *Thecalia concamerata* (Case 161), has an internal cup-like process within the valves, which serves as a nursing-pouch for the young.

The freshwater Mussels (*Unionidae*, Cases 166, 167) are an enormous group of over 1,400 living species. They are found in

FIG. 32.



A. *Unio graniferus.*



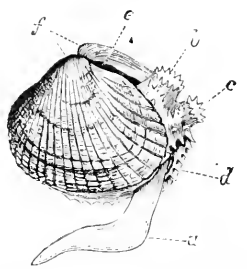
B. *Anodonta anatina.*

rivers and streams in most parts of the world, but are most plentiful in North America, where they are cultivated for commercial purposes (button-making, &c.). *Margaritana margaritifera*, which is found in the rivers of this country and of Europe, sometimes produces handsome pearls, for which it has been valued since Roman times. Various types of incubating chambers are developed in the gills.

The young Mussels of this family escape as larvae known as Glochidia, in which each valve of the shell has a hook at the edge.

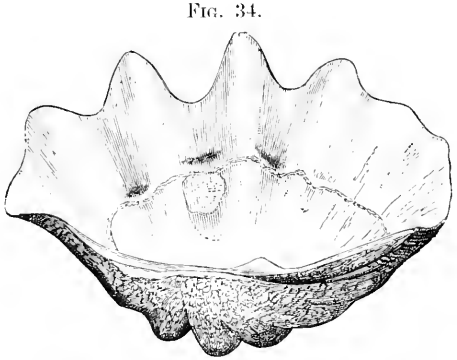
With these hooks a certain number of larvae succeed in fixing themselves upon fishes, and if they light upon soft tissue such as a gill-filament the irritation of the hook causes the flesh to grow over the Glochidium and to form a cyst round it. The larval Mussel develops within the cyst and lives parasitically on the fish until it is liberated by the breaking up of the cyst.

Fig. 33.



Common British Cockle (*Cardium edule*).
a, foot; *b*, exhalant siphon; *c*, branchial or inhalant siphon; *d*, edge of mantle; *e*, ligament; *f*, umbones or beaks of the shell.

Fig. 34.

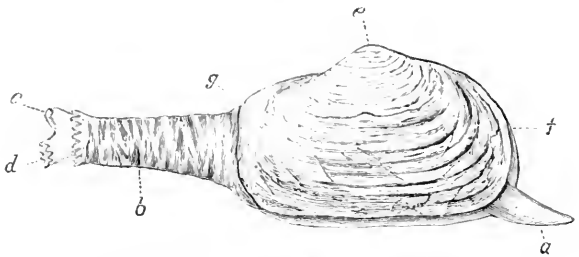


Left valve of the Giant Clam (*Tridacna gigas*).
Length, 36 inches. Weight, 154 lb.; weight of the two valves, 310 lb.

The *Tellinidae* (Case 179), *Veneridae* (Case 185), and the Cockles (*Cardiidae*, Case 192) are all remarkable for the diversity of colour and sculpture that their members exhibit.

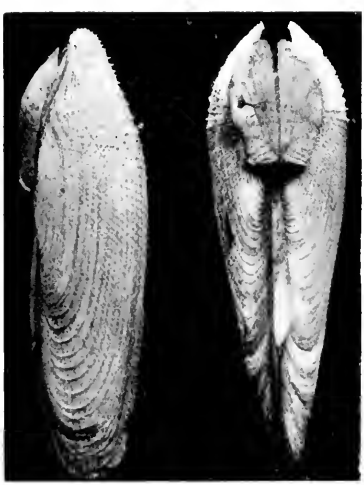
An interesting phase of Lamellibranch evolution is found at its maximum among many of the Eulamellibranch families now to be considered. There is a tendency in the class for the mantle edges to become fused at one or more points, and the resulting orifices at the posterior end may be very much elongated and

Fig. 35.



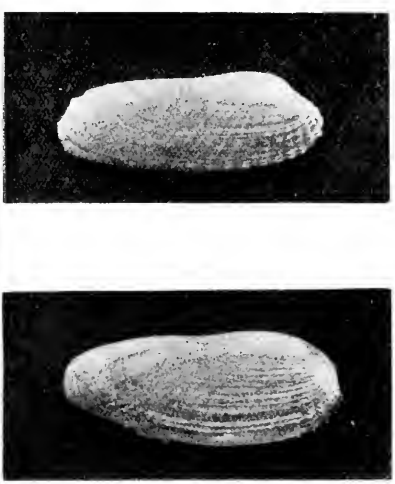
British Gaper (*Mya truncata*).
a. foot : *b*. siphon-sheath ; *c*. exhalant siphon ; *d*. inhalant siphon ; *e*. umbones or beaks ; *f*. anterior, *g*. posterior end of shell.

Fig. 36.



Shell of *Pholas dactylus*.
Side-view on the left showing rows of sharp teeth towards front edge above. Dorsal view on right showing additional plates between the valves. Reduced.

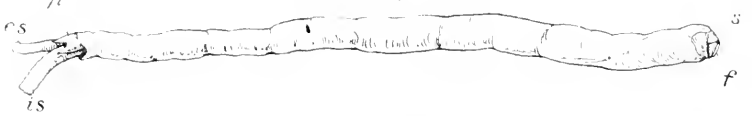
Fig 37.



Valves of *Petricola pholadiformis* (above), and *Pholas candida* (below).

extensible as 'siphons', which usually act as conduits for the admission of water into the branchial cavity and for the expulsion

Fig. 38.



A Ship-worm, *Teredo navalis*.
e.s. Exhalant siphon. *f.* Foot. *i.s.* Inhalant siphon. *p.* One of the pallets. *s.* One valve of the shell.

of waste products. *Yoldia* (among Protobranchs), *Tellina*, *Psammobia*, the *Veneridae*, and *Teredo* (Case 202) are examples of siphonate forms. In *Teredo* the siphons are enormous and allow the animal to burrow very deeply into wood.

The *Tridacnidae* (Cases 195, 196) contain the largest living Lamellibranchs, *Tridacna gigas*, the Giant Clam, sometimes weighing over 500 lb.

Many of the *Solenidae*, or Razor-shells, possess very elongated shells, and are remarkable for the great development of the foot, which can be pointed or contracted as may be required for burrowing into sand. By means of this powerful foot the animals, when disturbed, bore with such rapidity and to such a depth that their capture is a matter of great difficulty.

The *Pholadidae*, or 'Piddocks', are very remarkable molluscs having the power of boring into rock, timber, &c. The shell is strong and prickly and is used to enlarge the hole as the creature grows. The common *Pholas dactylus* (Fig. 36) of our own shores has been found in slate-rocks, mica-schist, coal-shale, sandstone, chalk, marl, peat, and wood. These animals are brightly phosphorescent. Certain species are used as food at many places on the shores of the Mediterranean.

The *Teredinidae*, or Ship-worms, are also borers, but do not perforate rocks. They are principally wood-borers, and they cause considerable damage to submarine timber structures.

Fig. 39.

Watering-pot Shell (*Brechites vaginifer*). Case 203.
a. bivalve shell of the very young animal.

The habits and structure of these and other wood- and stone-

boring animals are described in the *Guide to Marine Boring Animals* and are illustrated in a case in the Central Hall.

The 'Watering-pot shell' (*Brechites*), of the family *Clavagellidae*, is a long tubular structure with an expansion at one end, perforated like the 'rose' of a watering-pot. It does not represent the shell of an ordinary bivalved mollusc, and on looking carefully near the perforated end ('the rose'), two small valves (the true shell) will be seen embedded in the surface. They are found with the 'rose' downwards, buried in mud or sand at low water on the shores of the Indian and Pacific Oceans.

Order 4. **SEPTIBRANCHIA.**

(*Case* 204.)

The Septibranchia are a small group in which the gills are transformed into a muscular partition, which divides the branchial chamber into cloacal and inhalant portions. The Septibranchia are connected with the Eulamellibranchia through such forms as *Lyonsia*, in which the first steps in the development of muscular tissue in the gills can be seen. Respiration is effected by the inner surface of the mantle, the muscular septum by its contractions keeping up a continuous stream of water. From the form of the alimentary canal and the contents of the stomach it is inferred that these animals are carnivorous.

The Septibranchia are marine and may be found at great depths. *Poromya*, *Cetoconcha*, and *Cuspidaria* are the best known genera, of which the first and last are found in British waters.

Class V. **CEPHALOPODA.**

(*Cases* 205 *to* 208.)

The Cephalopoda include the Octopus, Cuttlefish, Squid, Nautilus, &c. They are Mollusca in which the edges of the foot are divided and extended to form long appendages and are in addition carried forward and joined in front of the mouth, which thus comes to lie in the middle of the foot. A portion of the latter (the epipodium) is expanded into a muscular tube, *the funnel*, by which the water contained in the mantle-cavity is expelled. The animals, which are exclusively marine, move head downwards when on the bottom. The position is changed in swimming, as they move with their visceral sac in front by means of jets of water vigorously expelled from the mantle-cavity through the funnel. The mouth is usually furnished with a formidable pair of horny beaks (mandibles), and the closely concentrated nervous ganglia are protected by a cartilaginous sheath. In some members of this class the eye possesses, in addition to a cornea, retina, and lens, a number of accessory

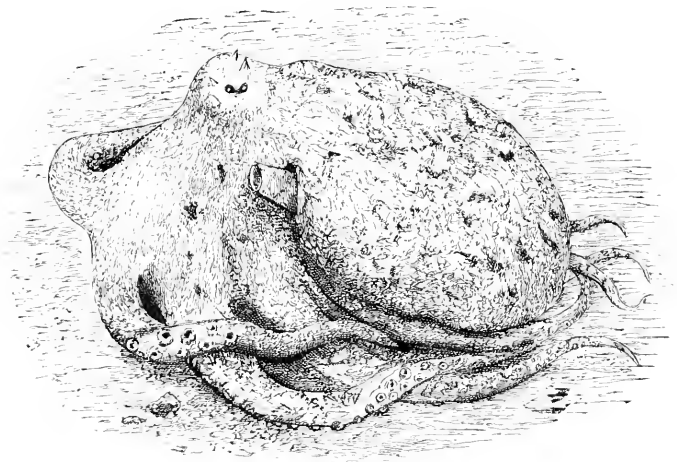
structures which render it a very complex and efficient organ comparable to that of the Vertebrata. Some of the arms are modified in the male for the purpose of pairing, and in some of the Octopoda the modified tentacle becomes detached.

A striking peculiarity of the class is the elaborate development of *chromatophores* in certain families. These are pigment cells

Fig. 40.

A, the upper, B, the lower beak of *Architeuthis monachus*; one-third natural size.

Fig. 41.



The Common Octopus (*Polypus vulgaris*), resting.

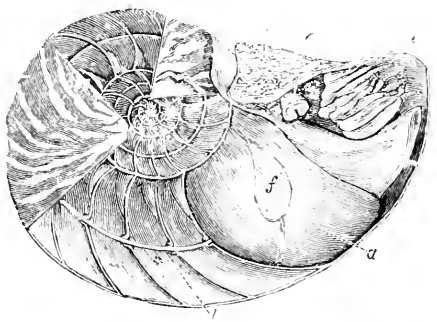
of various colours found in the skin and furnished with muscle fibres and a nerve supply. When stimulated by some shock or as the result of direct control by the nervous system the chromatophores of the same colour may all be contracted or extended. The colour of the animal is thus susceptible to rapid change and may be adjusted for purposes of protection.

All the Cephalopoda are marine, active, and carnivorous. They are divided into two orders—*Tetrabranchia* and *Dibranchia*.

Order 1. **TETRABRANCHIA.**

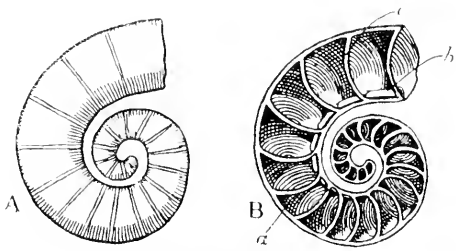
Nautilus, of which four species are known from the Indo-Pacific, differs from all other living Cephalopods in having two pairs of gills instead of one pair, and a large number of small retractile tentacles without suckers instead of eight or ten long arms. The shell is external, coiled, and formed of many compartments, of

Fig. 42.



The Pearly Nautilus (*Nautilus pompilius*).
a, body; *b*, siphuncle; *c*, eye; *d*, hood; *e*, tentacles; *f* muscle of attachment to the shell.

Fig. 43.



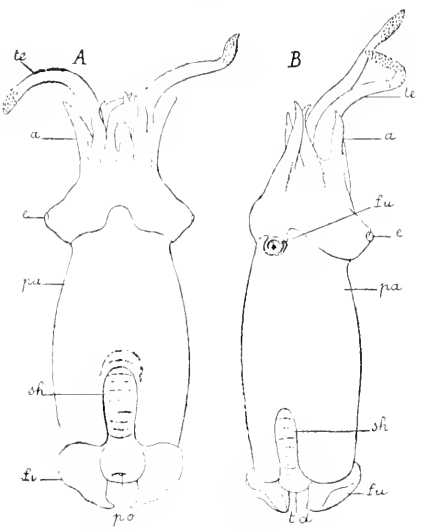
Shell of *Spirula peronii*.
A. Complete specimen. B. Section of shell showing septa (*a*) and siphuncle (*b*).

which only the last is occupied by the animal, although the septa between the compartments are traversed by a shelly tube containing a prolongation of the tissues of the mantle. *Nautilus* sometimes swims at the surface, but more often crawls about at the bottom in search of small Crabs, molluscs, &c., on which it feeds. According to Dr. Willey, who studied its habits in the Western Pacific, it is gregarious and nocturnal in its activities. The fossils known as Ammonites are shells similar in structure to that of *Nautilus*, and they are placed in this order.

Order 2. **DIBRANCHIA.**

The members of this order have a single pair of gills and eight or ten sucker-bearing arms. The shell may be coiled and many-chambered, as in the living *Spirula*, where it is almost wholly internal. In many fossil forms it is straight, and the chambered shell (phragmocone) dwindles and is replaced by secondary calcareous structures which lead to the calcareous 'cuttlefish-bone' of the living *Sepia* and the horny 'pen' of *Loligo* and other

Fig. 44.



Spirula. Dorsal aspect (A), ventral aspect (B). *sh.* shell; *e.* eye; *fu* funnel; *fi.* fins.

From Lankester's *Treatise on Zoology* (by permission of Messrs. A. & C. Black)

genera. Finally, in the Octopus (*Polypus*) the only vestiges of the shell are small chitinous stylets.

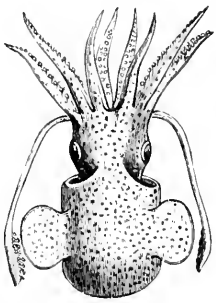
The *Dibranchia* are divided into two sub-orders—*Decapoda* and *Octopoda*.

The *Decapoda* have ten arms, the suckers on which are strengthened by horny rings which may bear hooks; two of the arms are retractile into special pouches and are known as 'tentacular arms'.

Some living Decapods attain a great size, e.g. *Architeuthis*, of which a model is suspended from the ceiling of the Gallery. There can be little doubt that some tales of 'Sea-serpents' are based on the appearance of such monsters. Complete examples

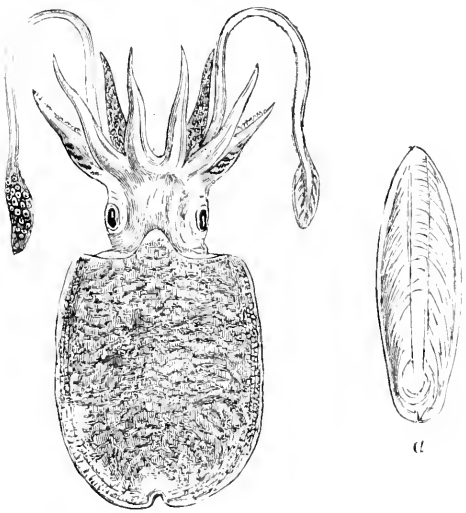
of *Spirula* (Case 207, Wall-case G) were for a time among the greatest rarities in zoological collections, though the shell is to be obtained in large quantities on tropical and sub-tropical shores.

Fig. 45.



Sepiola scandica (natural size). British.

Fig. 46.



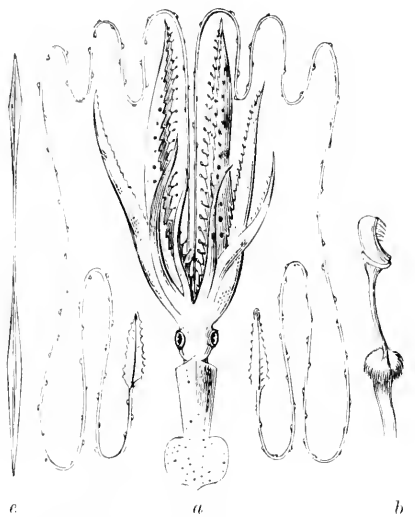
The Common Cuttlefish (*Sepia officinalis*), and its shell or 'bone' (*a*).

Quite recently, however (1922), the living animal has been taken in large numbers by a Danish Oceanographical expedition off the West Indies and in the Atlantic Ocean.

Great variety of shape and colour is found, and the development of lateral fins adds to the general diversity of form among the

Decapoda. *Doratopsis*, *Chiroteuthis*, *Ommastrephes*, and *Cranchia* (in which the arms are very short and the body is swollen and globular) are among the most striking genera. Some of the abyssal or deep-sea Decapoda are distinguished by the presence of remarkable luminous organs, which are borne on the mantle or near the eyes. In *Bathothauma* and *Toxeuma* the eyes are very large and are carried on long stalks.

Fig. 47.



Chiroteuthis veranyi (much reduced).
a, general view of animal; *b*, magnified view of pedunculated sucker of the terminal club of the tentacular arms; *c*, internal shell or gladius.

The *Octopoda* have eight arms and the body is rounded and short. The model of a large *Polypus punctatus* is suspended from the roof of the Gallery. The Paper-Nautilus (*Argonauta*) is remarkable in that the female secretes a special shell from the two dorsal arms, which serves as a brood-chamber (Wall-case G).

ALPHABETICAL INDEX

OF THE

PRINCIPAL FAMILIES AND GENERA OF MOLLUSCA EXHIBITED IN THE SHELL GALLERY.

This Index has been compiled to assist the numerous visitors, who wish to examine and determine specimens of shells, in finding, without trouble or loss of time, the Cases in which the genera are placed. Subgeneric terms are omitted, as they do not fall within the scope of this 'Guide'.

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